DOCUMENT RESUME

ED 094 353 CS 001 254

AUTHOR	Lucas, Jana M.
TITLE	Overgeneralization in Learning to Read.
PUB DATE	Apr 74
NOTE	15p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, Apr. 15-19, 1974)
EDRS PRICE	MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS	*Decoding (Reading); Elementary Education; Language Development; Pronunciation; *Reading Ability; Reading Development; Reading Instruction; *Reading Research; *Reading Skills; *Teaching Models

ABSTRACT

A rule-based model is proposed of how children learn to decode as they gain experience in reading. The model is based on data gathered from pronunciation errors of words presented in isolation. An analysis of the errors reveals that different kinds of errors are made by children at different ability levels. Less able readers make errors that reflect reliance on a decoding strategy that assumes an invariant letter-to-one-sound language structure. More able readers make errors that connote use of a strategy in which letter clusters are decoded instead of single letters and letter-sound invariance is not assumed to exist. The results indicate that the strategy a reader uses is closely tied to his ability to read. (Author)

OVERGENERALIZATION IN LEARNING TO READ

Jana M. Lucas

University of Illinois at Urbana-Champaign

Abstract

A rule-based model is proposed of how children learn to decode as they gain experience in reading. The model is based on data gathered from pronunciation errors of words presented in isolation. An analysis of the errors reveals that different kinds of errors are made by children at different ability levels. Less able readers make errors that reflect reliance on a decoding strategy that assumes an invariant letter-to-one-sound language structure. More able readers make errors that connote use of a strategy in which letter clusters are decoded instead of single letters and letter-sound invariance is not assumed to exist. The results indicate that the strategy a reader uses is closely tied to his ability to read.

Portions of this paper were presented at the Convention of the American Educational Research Association in Chicago, April 1974. The author wishes to thank the Urbana School District for permitting the author to test the children used in the study. She also thanks W. N. Zoellick for his participation in the testing, data analysis, and interpretation of results.

Biographical Resume

Name: Lucas, Jana M.

Address: 127 Children's Research Center
University of Illinois
Champaign, Illinois 61820

Title: Assistant Professor, Department of Educational Psychology

Degrees: B.A., Cornell University

M.A., University of Michigan

Ph.D., Stanford University

Specialization: Cognitive Development and Education

Affiliations: Member: AERA, SRCD

According to Goodman (1965) reading error measures are more important for understanding the reading process than are measures of accurate reading. Errors provide insights into how a child is processing printed information and, if the same types of errors repeatedly occur, the errors suggest what kinds of strategies the child is employing to read. In addition, a comparison of reading errors among children of different skill levels suggests which strategies are more effective and in which sequence they are used.

Studying reading errors is problematical in that no entirely satisfactory method of analysis has yet been devised. Biemiller (1970) set up three reading error categories, the first and second of which are overlapping. A graphic substitution error was scored when the child matched, minimally, the first letter of the printed word. A semantic-syntactic substitution error was scored when the response error fit the context. The third error type was a no-response error. It was used to demarcate a shift from one reading strategy to another. Weber (1967) devised a complex formula which measured the amount of graphic information a child was presumably using. The score is a measure of the amount of graphic similarity between the stimulus word and the response error based on a similarity of letter patterns. Y. Goodman (1968) used a psycholinguistic coding taxonomy that had been developed by K. Goodman (1965). Two measures coded the graphic and phonetic relationships between the stimulus word and response error while the remaining 26 measures coded nongraphic dimensions like the use of semantic or syntactic cues or voice tone variations. The graphic and phonetic measures served to identify the source of information the child was trying to use in reading.

In spite of an apparent arbitrariness in defining and categorizing reading errors, some common findings are worth noting. In all three studies, first graders were subjects and they were all given the same task, oral reading. Weber and Biemiller found a tendency for children to shift from a reliance on contextual cues in making guesses about words to a reliance on graphic information. Goodman

and Biemiller found that good readers tend to begin using graphic information sooner than do poor readers. Assuming traditional sorts of reading experiences, these results indicate that good readers make predictable shifts in the way they use printed information as they learn to read and that poor readers either do not make the shifts or make them more slowly than do good readers.

Locating shifts in learning to read implies that different strategies exist. Beginning readers appear to change to a different reading strategy when they become more skilled. Moreover, the strategy shift appears to signify progress in learning to read because those children who make the shift more slowly are also the poorer readers at the end of the school year (Biemiller, 1970). One implication is that reading is much more than memorizing words or learning letter-to-sound correspondences. It is a process of developing increasingly more effective strategies for assigning meaning from printed information. If true, determining what these strategies are and how they differ among high and low achieving readers should facilitate our understanding of the learning-to-read process.

The problem incurred in studying developing reading strategies is that the data are dependent upon obtaining accurate and unambiguous reading error measures. Data derived from oral reading errors are not without ambiguity. For example, a child whom we studied was reading a paragraph aloud and said, "The first creatures we stopped . . ." The last word should have been read "spotted." How should that error be categorized? The response error obeys syntactic and semantic constraints as well as conforming to most consonant and vowel restraints. Since determination of reading strategy depends upon identifying the reader's source of information, it is clear that this child's response cannot be categorized. One solution to the problem is to eliminate two of the three sources. If context is eliminated by presenting words in isolation, pure measures are then available of the reader's use of graphic information. This procedure has an additional advantage. Stimulus words can be chosen based on word property characteristics. If certain word proper-

ties affect particular strategies, then sets of stimulus words may be analyzed with respect to the errors generated. In this way not only is information obtained about which graphic-based strategies children use in general but also inferences may be made about which kinds of words play a role in making a particular strategy effective or ineffective.

The theoretical framework for this study is taken from the language development research (Brown, 1973; Sloben, 1971). Language studies of young children show that in the process of learning grammatical rules for speech, children often correctly imitate adult patterns at first but then overgeneralize the regular patterns to irregular forms. Because children are neither taught the rules for speech regularity nor do they hear adults use the overgeneralized forms, it is reasonable to infer that rule strategies are developed by the children as they hear and use language. From this it follows that overgeneralization errors can serve as a signal that regular patterns were noticed and have been encompassed into a rule schema.

There are important similarities between language learning and learning to decode in reading. Untaught complex rules exist which delineate appropriate grammatical forms in the one and correct letter-pattern pronunciations in the other. Since overgeneralization of regular syntactic structures is characteristic of speech development, it should be possible to observe instances of overgeneralization of regular pronunciation rules to words containing an irregular pronunciation.

An effective way to observe such instances in reading is to ask children to pronounce unfamiliar words which contain an irregular vowel or vowel digraph. In this case, word familiarity and vowel regularity are the word properties of interest in the same way that regular and irregular verb forms are of interest in studies of language development. Instances of overgeneralization reveal the kinds of rule-based strategies the reader is dependent upon for decoding. Presumably, the better readers make overgeneralization errors that reflect more effective rule strategies.

Presumably, also, a developmental sequence of rule strategies prevails that is dependent on the frequency of occurrence of letter-sound patterns. Less skilled readers should make overgeneralization errors on the more commonly-occurring patterns because these patterns are more easily noticed. The more skilled readers should correctly pronounce the common patterns but make overgeneralization errors on the less common patterns. Thus, not only should overgeneralization errors reveal acquisition of the rule schema in decoding but categorizing the errors according to the commonness of the pattern should distinguish skill in decoding.

Design and Materials

Materials for the Isolated Word Test (I.W.T.) consist of 32 four and five letter monosyllabic words. Sixteen are familiar and 16 unfamiliar, 16 are spelled with one vowel and 16 with a vowel digraph, and 16 are classified as regular and 16 as irregular. Familiarity is defined on the basis of high and low frequency of usage values from Kucera and Francis (1967). Regularity is defined on the basis of the commoness of the vowel-sound pattern. Regular patterns consist of the most commonly occuring pattern while irregular patterns are any other pattern. The 32 stimulus words comprise a 2 x 2 x 2 factorial design.

Children from grades one, two, three, and four were tested individually. The test words were hand-printed on 3 x 5 cards and displayed one at a time. The children were asked to read each word and to guess when they were not sure of the pronunciation. All responses were written down during the testing.

Response Error Coding

All pronunciation responses were classified correct or not correct. If not correct, one of the following errors was coded (examples of each error type are listed in Table 1):

1. No response (child refuses to guess)
2. Initial Consonant error (the first sound of the response does not match the first letter of the stimulus word)*

3. Vowel mismatch (the vowel sound does not match any vowel in the stimulus word)**

4. Short vowel sound error (a vowel or a vowel digraph is pronounced using a short vowel sound)**

5. Long vowel sound error (a vowel is pronounced using a long vowel sound or a vowel digraph is either given a long sound or the most commonly occurring pattern for that digraph)**

- - - - - - - - - - - - - -

Insert Table 1 about here

- - - - - - - - - - - - - -

Preliminary Analysis

The total number of correct responses on the IWT given to fourth grade children (N=51) was compared with Stanford Diagnostic Reading Test scores which the school had given three months previous to our testing. Correlations between the IWT and each Stanford subtest was significant at $p<.01$. The correlations are listed in Table 2. The significant positive correlations between IWT and the Stanford Test served to justify dividing children into ability groups based on the IWT score. All the children tested in grades 1 - 4 were ranked according to their total score and then separated into four decoding ability groups. The results of the study are based on comparisons among these ability groups.

- - - - - - - - - - - - - -

Insert Table 2 about here

- - - - - - - - - - - - - -

Six of the 95 children tested made no mispronunciation errors while two children made 31 errors. These eight children were excluded from further analysis. The error range of the remaining 87 children was between one and 27 errors.

Five error-type responses were coded initially. The first, a no-response error, occurred only among the lowest ability group. As a result, it was decided

that the errors on this measure should be added to the second, an initial consonant error, and be analyzed as one error type. The regrouped error type variables and scores for each group are listed in Table 3.

- - - - - - - - - - - - - -

Insert Table 3 about here

- - - - - - - - - - - - - -

Since there were an unequal number of errors and subjects within each ability group, raw scores could not be used for analysis. Each child's raw score for each error type variable was changed to a proportional score and then normalized using an arc sin transformation. Although the transformation increases the number of different scores and eliminates skewness, it also has the effect of misrepresenting zero error scores of those students who have a low total error score. For example, although no one in the high ability group made an initial consonant or a no-response error, the mean arc sin transformation of the proportion of these kinds of errors was higher for this group than were the transformations for groups who did make errors. This artifact makes the overall test of significance more conservative.

A multivariate statistic, Wilks' Lambda, was chosen for analysis of the data. It was necessary to use a multivariate statistic because the four error type responses represent a multiple of dependent variables whose effects must be tested simultaneously. It would be trivial to consider total error differences among ability groups. What was of interest here are the differences in the kinds of errors made among ability groups. Wilks' Lambda provides an extension of a one way analysis of variance to a multivariate solution. The significance of the overall difference among ability groups for the four error response variables can be tested using Rao's R-Statistic which is distributed approximately as a F-variable (Tatsuoka, 1971, p. 84-89). The analysis was expected to show a significant difference in the kinds of pronunciation errors made by children who differ

in their ability to decode.

Results

As expected, there is a significant effect of the error variables as a function of ability to correctly pronounce words on the IWT. Rau's R test for Wilks' Lambda shows the overall effect to be significant at the .001 level, $F(12,211) = 13.39$. Table 4 lists the distribution of error type responses. It can be seen from the table that, in general, no-response errors and initial consonant errors occur infrequently. The exception is the least skilled reading group. About 21% of this group's errors are either no-response or initial consonant errors. Vowel mismatch errors account for between 14 and 37% of the errors with the less skilled readers making a greater proportion of these errors. A more striking ability by error interaction is evident in the vowel overgeneralization error types. The short vowel response increases as the number of errors increases while the long vowel response decreases as a function of total error.

Insert Table 4 about here

Analysis of the letter position error reveals the medial vowel to be the principal source of error. Approximately 89% of all errors involve the medial vowel only or the vowel plus an adjacent consonant. Initial and final consonant errors are infrequent, occurring 5 and 8% respectively. This distribution pattern of errors is also characteristic of low-ability decoders. Almost 87% of the errors made by the lowest scoring group of 14 children are vowel errors.

The kinds of medial vowel errors children make can be separated into three categories: (1) vowel mismatch, (2) short vowel error and (3) long vowel and major vowel digraph pattern error. Each kind of error comprises about 1/3 of the total number of vowel errors. The short and long vowel errors are the errors of interest since they represent errors of overgeneralization. The vowel mismatch error seems

to be a loose collection of other kinds of errors, including carelessness. Overgeneralization errors reflect occasions in which the reader does *not make a* wild guess about the vowel sound but uses a vowel sound that matches a predominant, regular vowel-to-sound pattern. The error becomes evident when the reader is asked to pronounce words that violate a regular pattern. He makes an error because he treats the vowel as if it were regular.

There are three response types for each of the overgeneralization errors. If the child has made a short vowel rule error, it typically occurs (1) in a response to an irregular one-vowel word (e.g., RIND is pronounced RǏND), (2) in a response to a word in which the vowel is followed by a consonant that affects that vowel sound (e.g., SPURN becomes SPRUN or CURT is pronounced CUT), or (3) in a response to a word which includes a vowel digraph (VAIN is read VAN or VIN). If the child has made a long or major vowel pattern rule error, it typically occurs (1) in a response to an irregular vowel digraph (HEAD is pronounced HEED, CROUP is CROWP), (2) in a response to a word containing a consonant which alters the vowel sound (GOURD is changed to GROUND, GUILD to GUIDE), (3) in a response to a one-vowel word (MALT is read M̄ALT). Table 5 lists five words that elicited the most similar error-type responses. All of these responses conform to short or long vowel rule errors. The high proportion of similarity demonstrates how frequently the same overgeneralization error response occurs for some words.

- - - - - - - - - - - - -

Insert Table 5 about here

- - - - - - - - - - - - -

Discussion

The purpose of the Isolated Word Test is to explore the relationship between reading skill and strategies for decoding words by analyzing the kinds of error responses that children make. An early study (Lucas, 1972) indicates that scores on a pronunciation task are significantly correlated with reading ability. The

study also shows that the ability to decode vowel sounds correctly is the best predictor of second grade children's scores on a standardized reading achievement test. When the study was replicated using mentally retarded readers (Lucas & Zoellick, 1974), it was found that retardates behave similarly to the least skilled normal readers. They make limited use of vowel sound rules and are profoundly restricted by word familiarity. That is, they can pronounce familiar words but not unfamiliar words. In the present study, the significant correlational effects between scores on the IWT and a reading achievement test affirm the earlier results. The IWT discriminates high from low-ability decoders and makes possible an error responses comparison.

The results of the IWT show that the kinds of errors children make differ as a function of reading ability. Comparisons of the kinds of errors indicate that children who differ in reading competency use different decoding strategies. The less competent readers decode fewer letters in the words pronounced and use less effective vowel sound rules when they do decode than do the more competent readers.

Two systematic sorts of errors occur only among readers who have minimal decoding skills. These children make a large proportion of no response errors and initial consonant errors. Generally, they recognize the more familiar words and then either decline to respond or else decode one to three letters in a word and guess the rest of the word. Further, they tend to repeatedly use the same short vowel sound regardless of which vowels appear in the word. For example, a fourth grade child preferred a short /i/ sound. She pronounced the words GLAND, PLAID, TRAIN and TURN as DID, PLIND, TING, and TRIP. A second grade boy preferred a short /u/. LUT, RUT, BUT, and SUK were his responses to LIGHT, RAIN, DUST, and STEAK.

The next group consists of children who mispronounce about 1/3 of the words. These readers tend to use a short vowel sound instead of a long vowel sound. The effect may be partially due to instruction since beginning readers are usually

taught short vowel sounds before long vowel sounds. However, the fact that low-achieving readers in first through fourth grade respond similarly weakens an instructional effect argument. Clearly, by fourth grade even the lowest-ranked readers receive some long vowel training, yet the error responses they make do not reflect that training. An instructional effect argument is further weakened by the many instances of pronunciation errors where /l/ or /r/ following a vowel is moved to a position preceding the vowel. The result, of course, is that the vowel sound is no longer affected by the consonant and can be assigned a short sound. Obviously, children were never taught to overapply a short vowel rule in such an indiscriminant manner. The alternative interpretation which is espoused here is that, regardless of instruction, the kind of error a reader makes is directly affected by the kind of decoding strategy he is capable of using.

The higher ability readers tend to decode short vowel words correctly and overgeneralize a long vowel or vowel digraph rule. Words containing one vowel can be unfamiliar and irregular but are usually correctly decoded. Examples includes words like CURT, TORT or BIGHT. Words containing a vowel digraph tend to be correctly pronounced if they are regular but not if they are irregular. Thus, words which contain regular vowel sounds like VAIN, POUND, and SEAT are usually correct while words containing irregular sounds like PLAID, GOURD, or STEAD are pronounced as though they were regular. These readers have apparently mastered the majority of decoding rules for one-vowel words. They have not mastered the set of decoding rules for vowel digraphs. As a result, the most prevalent digraph rules are overapplied to words containing irregular vowel digraph sounds.

The highest ability readers make very few errors. Errors tend to be made on very uncommon irregular vowel patterned words. Uncommon refers here to the frequency of occurrence of a vowel sound pattern. That is, of the set of irregular words, some contain less commonly occuring patterns than do others. For example, the word PLAID contains a less frequently occurring irregular pattern than does

the word NOOK and, in our response data, was mispronounced more often. When errors were made on the uncommon pattern, the regular sound pattern prevailed. Thus, these children also made overgeneralization errors but only on words containing relatively uncommon vowel-sound patterns.

The kinds of errors that readers make are interpreted by proposing an increasingly sophisticated set of decoding strategies. At a beginning stage in reading it is apparent that children acquire the consonant sounds, but are very confused by the vowels. At first they ignore the vowels or use a completely inappropriate rule, for example, one in which all vowels are assigned the same sound. Next they formulate a letter-sound invariance strategy. They assign one sound to each letter, giving vowels the short sounds. When they read words which contain consonant or vowel digraphs, one of the letters is usually ignored and the other letter is assigned its invariant sound. LIGHT may be pronounced LIT or LIGIT, RAIN is RAN, etc. Another invariance strategy occurs in words where a consonant following a vowel affects that vowel sound. Here, the consonant is either moved to the beginning of the word or is ignored. For example, SPURN may be pronounced SPUN, BULB is BLUB, or HURT is HUT. Letter-to-one-sound invariance is characteristic of the lower-ranked readers. The better readers make errors that reflect an understanding of letter cluster-to-sound regularity. A letter-to-one-sound invariance is abandoned and replaced by a more sophisticated kind of invariance. The most common sound for each vowel digraph is acquired as are vowel-consonant cluster patterns like /old/ or /ight/. This invariance strategy is reflected in a shift to correct pronunciations of words containing a single irregular-pattern vowel digraph. In addition, the response made to the irregular vowels tends to be the same response error. For example, irregular one-vowel words like SALT and MALT are usually correctly pronounced as are TURN and SPURN; also regular vowel digraph words like RAIN and LAIN, and COAT and MOAT are pronounced correctly. Words containing irregular vowel digraphs as in SWEAT, STEAK, GUILD, PLAID, or GOURD are typically mispro-

nounced to say SWEET, STEKE, GUIDE or GLIDE, PLAYED and GROUND. Each of these errors reflects a major pattern substitution and in two of the words the rule strategy overrides the letter order, as in the error responses GLIDE and GROUND. Thus it appears that different strategies for decoding prevail at different skill levels in reading which affect which letters are perceived together, in what order they are perceived, and which sounds are chosen for the letters.

An important characteristic of the error response data is the consistency with which all letters in the words are decoded. Among all but the lowest-achieving readers, errors occur not because letters are ignored but because the wrong decoding strategy has been employed. An explanation for this finding may be obtained from tachistoscopic studies with adults.

Kolers and Katzman (1966) analyzed perceptual errors of sequentially presented six-letter strings. When the letters were presented at less than 125 msec., subjects would sometimes report all the letters correctly but in the wrong order. At that time, a parallel processing mechanism was suggested to explain the effects. More recently, Kolers (1970) proposed an alternate explanation which is that correct visual scanning of letters consists of three stages. The reader scans to form an initial schematization, he orders the schematic elements, and then he fills in the ordered elements according to the schema. A reader who reports letters in an incorrect order may have done so because his initial schematization differed from the one actually appearing.

The pronunciation task results indicate that children form an initial schematization of the words they are trying to decode. Moreover, differences in the type of response error for children of different abilities imply use of different schemata. Children who classify vowels using a short vowel schema ignore additional vowels and consonant ending patterns. Children who classify vowels using a long vowel schema ignore less common sound patterns. Children using either schema reorder some consonants so that the schema is still valid. The response data indicate

that decoding is bound by the strategy the unskilled reader uses. The theoretical explanation espoused here is that the child's reading strategy determines the initial schematization. Then the letters in the word being decoded are ordered and finally are filled in, in conformity to the schema being employed.

Conclusion

An identification of different decoding strategies among unskilled readers provides a framework for suggesting that the acquisition of decoding skills occurs in a particular sequence based on the strategies the reader can organize. Beginning readers are limited to simplistic strategies because they have a very meager understanding of letter-sound regularity. As children obtain more experiences decoding and memorizing words, they devise strategies that include the more obvious forms of regularity. Consonants are the easiest since these generally can be decoded with an invariant letter-sound coding. This is evident in the response data which shows that consonants are seldom decoded incorrectly. Short vowel sounds predominate in beginning reading texts so may be acquired before long vowel sounds. This effect again matches the data. Nearly every child mispronounced more words containing a vowel digraph than words containing a single vowel. Once each letter is assigned a single sound, it seems likely that the reader resists acquiring additional sounds for the symbol. A single-letter-single-sound strategy is reasonably adequate for beginning reading texts and once established, it takes not only failure with the present strategy but also a sense of what alternate strategy can be substituted before a reader can shift. This may be why so many of the low-achieving readers tested did not use vowel digraph rules. They made errors on irregular one vowel words and on most words containing vowel digraphs. They also confused consonants like /s/ and /c/ or /g/ and /j/. These children are locked into an inappropriate letter invariance decoding strategy.

Once readers realize that letters can hold more than one sound and still be rule bound, they make a shift to a letter-cluster decoding strategy. As Venezky demon-

strated (1970) recognition of spelling-to-sound patterns does involve knowledge of sounds for letter clusters rather than for single letters. The rules for decoding letter strings are complex but they do exist. Readers who have shifted to a letter-cluster strategy are not hampered by unfamiliar words. They recognize most of the common letter cluster patterns and many of the less common letter cluster patterns also. When they are asked to decode words out of context, they make very few errors, and the errors they do make reflect a strategy based on letter cluster rules.

Footnotes

* A consonant error was coded in preference to a vowel error. For example, the response OAT to the word COUNT was coded as an initial consonant error, not as a vowel error. There were two reasons for this decision. One, to simplify the analysis, it was important to avoid double coding. Two, since an initial consonant error was almost invariably made by the least skilled readers, it is a useful code for distinguishing this group of readers from the more skilled groups.

** A consonant error other than an initial consonant error occasionally occurred in the response data. There were ignored in the coding (i.e., collapsed within each vowel error code) not only because the errors occurred infrequently but also because a majority of those that did occur appear to be linked to vowel errors. Consonants like /l/ or /r/ following a vowel and affecting the vowel sound tended to be moved or ignored in the incorrect pronunciation response.

Table 1

Examples of Response Errors of Words on the IWT

Error Code	Stimulus	Response
(2) Initial consonant	reap lour	pear grour
(3) Other vowel sound	spurn sang	spin sung
(4) Short vowel sound	find count	filled cut
(5) Long vowel sound or major pattern sound	gourd plaid	ground played

Table 2

Correlations Between the Isolated Word Test and the Stanford Diagnostic Reading Test by Grade Four Children (N=51)*

	1	2	3	4
1 Reading Comprehension				
2 Vocabulary	.660			
3 Beginning and Ending Sounds	.450	.369		
4 Sound Discrimination	.402	.313	.397	
5 Isolated Word Test	.504	.425	.549	.427

* When p=0 and n=50, a correlation of .36 is significant at p<.01

Table 3

Scores of Each Error Type for Four Ability Groups[1] in Grades One Through Four On the IWT

Pronunciation Error Raw Score Total[2] and Transformed Score[3]	Low Ability (N=14)	Low-Middle Ability (N=13)	High-Middle Ability (N=25)	High Ability (N=35)
No Response	21	0	0	0
Initial Consonant	21	6	5	0
Arc Sin Mean Score	0.666	0.420	0.489	0.793
Vowel Mismatch	95	56	39	9
Arc Sin Mean Score	1.236	1.247	1.035	1.011
Short Vowel	113	43	39	12
Arc Mean Score	1.362	1.115	0.989	1.073
Long Vowel	29	45	73	48
Arc Sin Transformation	0.627	1.209	1.493	1.854

1. The low ability children each made 16 or more errors, the low-middle group made 10-15 errors, the high middle group made 4-9 errors, and the high group made 1-3 errors on the test.
2. This is a total of each error type made by all the children within a group.
3. Raw score data for each individual was changed to proportional scores and transformed. This score is the mean arc sin for each error type made by all the children within a group.

Table 4

Proportional Scores of Each Error Type on the IWT by Children in Grades One Through Four (N=87)

	Low Ability		Low-Middle Ability		High-Middle Ability		High Ability
Group N	7	7	7	6	12	13	35
Mean # Errors	23.14	16.71	13.86	11.17	8.42	4.92	1.91
Range of Errors	20-27	16-18	13-15	10-12	7-9	4-6	1-3
<u>Type of Error</u>[1]							
No Response	.100	.043	.000	.000	.000	.000	.000
Initial Consonant	.111	.026	.031	.045	.030	.031	.000
Vowel Mismatch	.321	.368	.340	.343	.248	.250	.135
Short Vowel Response	.432	.368	.289	.299	.337	.187	.179
Long Vowel Response	.037	.197	.340	.313	.386	.531	.689

[1] Proportions are based on the total numbers of errors within each of the seven groups.

Table 5

Examples of Similarity of Error Response for Unfamiliar Irregular Vowel Words To the IWT

Stimulus Word	Most Common Error Response	Proportion of this Response Over Total Error Response	Type of Error
RIND	rǐnd	.58	short vowel rule
GOURD	ground	.78	major pattern digraph rule
PLAID	played	.68	long vowel rule
STEAK	steck	.45	short vowel rule
CROUP	crop	.42	short vowel rule

References

Brown, R. The development of language in children. In G. Miller (Ed.), Communication, Language and Meaning. New York: Basic Books, 1973.

Biemiller, A. The development of the use of graphic and contextual information as children learn to read. Reading Research Quarterly, 1970, 6, 75-96.

Goodman, K. S. A linguistic study of cues and miscues in reading. Elementary English, 1965, 639-643.

Goodman, Y. A psycholinguistic description of observed oral reading phenomena in selected young beginning readers. Unpublished doctoral dissertation, Wayne State University, 1967.

Kolers, P. A. Three stages of reading. In H. Levin & J. P. Williams (Eds.), Basic studies on reading. New York: Basic Books, 1970. Pp. 90-118.

Kolers, P. & Katzman, M. Naming sequentially presented letters and words. Language and Speech, 1966, 9, 94-95.

Kucera, H. & Francis, W. Computational analysis of present-day American English. Providence, R. I.: Brown University Press, 1967.

Lucas, J. M. A stage processing model of reading for elementary school pupils. Unpublished doctoral dissertation. Stanford University, 1972.

Lucas, J. M. & Zoellick, W. N. Developmental testing of both normal and retarded readers: A diagnostic method that suggests remedial strategies. Unpublished manuscript, 1974.

Slobin, D. Psycholinguistics. Glenview, Ill.: Scott, Foresman, & Co., 1971.

Tatsuoka, M. M. Multivariate analysis: Techniques for educational and psychological research. New York: John Wiley & Sons, 1971.

Venezky, R. L. The structure of English orthography. The Hague: Mouton, 1970.

Weber, R. First grader's use of grammatical context in reading. In H. Levin & J. P. Williams (Eds.), Basic studies on reading. New York: Basic Books, 1970. Pp. 147-163.